Objective:

Calculate the percentage of Na_2CO_3 in the unknown sample:

Assuming that:

Part I (molarity of HCl by standardization):

a) 1000mL of ~ 0.1 mol of HCl was prepared by diluting 12.06 **mol** concentrated HCl
b) 0.1855 g of (dry/room temp.) Na_2CO_3 was weighted and used for titration.
c) In average, 35.18 mL HCl was consumed to the end point of titration.
d) Calculate the ***exact*** molarity of the HCl solution:

$$\frac{0.1855\ g}{106.0\ g/mol} \times \frac{2\ mol\,HCl}{1\ mol\,Na_2CO_3} \times \frac{1000\,mL}{35.18\,mL} = 0.0995\ M$$

Part II (determination of sodium carbonate in unknown)

a) The consumed volume of HCl for the unknown sample = 43.20 mL (First titration)
b) The mass of the dried unknown sample = 0.9113 g (First sample)

Solution:

(0.0995 mol)/ (1000 mL) × 43.20 mL = 4.298×10^{-3} mol HCl
(1 mol Na_2CO_3/2 mol HCl)(4.298×10^{-3} mol HCl) = 2.149×10^{-3} mol Na_2CO_3

Mass = mol × Molecular weight
Mass of Na_2CO_3 = (2.149×10^{-3}) (106.0) =0.2278 g

The Na_2CO_3 % in the unknown sample for the first titration:
X_1 = [(0.2278 g Na_2CO_3)/ (0.9113 g unknown)] × 100 = 24.99 ≈ 25.0 %
X2 (for the second titration)
Xn (for the nth titration)

X_{ave} = (25.0 + X_2 + X_3 + … +X_n) / (number of titrations)

Notes:
Standard Deviation: SD
Relative Standard Deviation: $RSD = \frac{SD}{mean}$
RSD (ppm) = RSD × 1000
95% $CL = mean \pm \frac{(t \times SD)}{\sqrt{n}}$